TIERRA SOLUTIONS, INC.

Transmitted Via Electronic Mail & Federal Express Delivery

April 16, 2014

Emergency and Remedial Response Division
U.S. Environmental Protection Agency, Region 2
290 Broadway, 19th Floor
New York, New York 10007-1866
Attention: Ms. Jennifer LaPoma, Remedial Project Manager

Re: Response to USEPA Comments & Revised Statement of Work
Lower Passaic River Study Area – River Mile 10.9: Pipeline Survey
Unilateral Administrative Order
USEPA Region 2 CERCLA Docket No. 02-2012-2020

Dear Ms. LaPoma:

Submitted herewith are responses to United States Environmental Protection Agency's (USEPA) April 3rd comments to the Pipeline Survey Statement of Work (SOW) as well as a revised SOW for your review. The requested Quality Assurance Project Plan (QAPP) and Health and Safety Plan (HSP) will be submitted for review by April 25, 2014

If you have any questions, please contact me at (732) 246-3091.

Sincerely,

Tierra Solutions, Inc.

Paul J. Bluestein, P.E.
Project Coordinator
On behalf of Occidental Chemical Corporation
(as successor to Diamond Shamrock Chemicals Company)

Attachments

10th Floor
Two Tower Center Blvd. East Brunswick, New Jersey 08816

Cc: (electronic)

Sarah Flanagan, USEPA
Ray Basso, USEPA
Stephanie Vaughn, USEPA
Derrick Vallance, Maxus Energy
Carol Dinkins, Vinson & Elkins

RESPONSE TO USEPA COMMMENTS
PASSAIC RIVER RIVER MILE 10.9
PIPELINE SURVEY: STATEMENT OF WORK (SOW)

1. *Please state in the SOW how access and notice will be addressed. A preliminary list of contacts has been provided directly below. Please let EPA know if you need any additional information:*
    a. *In regards to the shoreline access in the survey area, the Bergen County Parks Department should be contacted. Ronald Kistner, the Director, can be contacted at: Ronald Kistner, Director, One Bergen County Plaza, Fourth Floor, Hackensack, NJ 07601 Phone Number: 201-336-7275*
    Email Address: R.Kistner@co.bergen.nj.us
    b. *Township of Lyndhurst Fire Department operates a boat launch for use in cases of emergencies.*
    c. *If a boat with an air draft more than 7 feet is used, please contact the bridge operators.*
    d. *In-river users such as boating clubs and local township high school rowing crews are notified prior to the commencement of work.*

    The SOW has been revised to address site access and notifications. Further, the survey boat intended for use has an air draft of 1 meter (3.28 feet).

2. *Pursuant to Section X, Paragraph 24, please submit a HSP for the planned work. As a reminder, EPA may recommend changes to the HSP, but EPA does not approve HSPs.*

    A Health and Safety Plan (HSP) will be prepared and submitted by April 25, 2014.

3. *Pursuant to Section X, Paragraph 25, please submit a QAPP for review and approval prior to the commencement of work.*

    A QAPP will be prepared and submitted by April 25, 2014

4. *If available, please provide project descriptions (and images) showing successful delineation of a subsurface pipeline in previous projects by the University of Illinois. While described as having extensive experience in both PBS and GPR, the contractor did not provide any supporting qualifications or final product images of locating a subsurface pipeline from its own work (just from the PBS manufacturer).*

    The University of Illinois (UoI) has extensive experience in using PES and GPR as stated, but has not used these techniques for subsurface pipeline detection. Examples of our PES work were provided in the SOW (Figure 2), as well as reference to a recent paper showing the high resolution possible. GPR data was also presented in Figure 4 of the SOW, again demonstrating the excellent potential resolution of this technique.

5. *Please provide a response to the following Kinematic DGPS positioning questions and clarify within the draft SOW:*
    a. *How will the base station be established (OPUS solution, local broadcast)?*

        The UoI will implement, upon QA/QC verification, the system of available and present benchmarks. If these benchmarks are not available, or do not pass survey specification standards, a New Jersey Professional Land Surveyor (PLS) will be contracted to establish a series of benchmarks (3) along the survey corridor. Clarification is included in the revised SOW.

    b. *What local area benchmarks will be used as check points, and how many?*

RESPONSE TO USEPA COMMMENTS
PASSAIC RIVER RIVER MILE 10.9
PIPELINE SURVEY: STATEMENT OF WORK (SOW)

Please refer to the response to comment 5.a.

1. *It is recommended that 3-4 be used to verify/validate the temporary point for QC purpose (in case 1 or 2 locations are of poor accuracy).*

   Three (3) benchmarks will be used during the survey.

2. *How will poor satellite visibility in the shoreline trees be accounted for during either the PBS or, more likely, the GPR surveys?*

   Poor satellite visibility will be managed by conducting the bulk of our survey efforts when satellite constellation configurations will be at their peak or best, depending on the periods of high tidal flow (high tides in early June 2014 are around midday when satellite constellations are also often at their optimum).

6. *In order to provide the best chances at high quality data, the surveys should be planned around as high a tide as possible for the PBS, and as low a tide as possible for the GPR.*
   a. *This will allow the PBS to measure as far inshore as safely feasible, and may allow the GPR to survey offshore in the mudflat, if the water level is low enough.*
   b. *Overlapping PES and GPR data will only serve to add confidence in determining the pipeline location.*

   Agreed. PES surveys will take place as near to high water as possible, with possible GPR surveys on the intertidal mudflat at low water. GPR surveys in the adjacent park will be conducted at high water to maximize time efficiency.

7. *Please provide a response to the following questions related to gas bubbles in the sediment that might be a concern (as noted in the SOW):*
   a. *Do the Univ. of Illinois personnel have experience trying to measure data in sediments that contain gas bubbles? If so, what potential alternative tactics can be employed?*

      The UoI has deployed the PES in several environments in which subsurface gas has been present. Unfortunately, the underlying physics of the acoustic signal result in poor or no results when gas is present. Past work has often shown the presence of patches of gas, rather than gas throughout the entire sediment column, but this issue can only be identified by deployment of the PES.

   b. *Have alternative technologies been considered if the acoustic system (i.e. PES) is unsuccessful (e.g. magnetometer if the pipelines are constructed of ferrous materials and/or electrical resistivity imaging)?*

      Past work by the CPG has shown limited success with magnetometer surveys whilst electrical resistivity imaging is unlikely to possess the potential vertical resolution that is provided by the PES.

8. *When EPA approves the SOW, please provide a schedule containing calendar dates, at least one month in advance of mobilization. Please note that this study effort will need to be coordinated with the on-going*

RESPONSE TO USEPA COMMMENTS
PASSAIC RIVER RIVER MILE 10.9
PIPELINE SURVEY: STATEMENT OF WORK (SOW)

River Mile 10.9 capping efforts. Based on CPG's current schedule it is anticipated that their River Mile 10.9 operations will be completed in mid-May 2014.

A timetable has been provided in the SOW and a schedule will be included within the QAPP. Further, the field work has tentatively been scheduled to commence the week of June 2nd to avoid possible conflicts with the on-going RM 10.9 Removal Action. This projected start date should provide for sufficient time to have in place an USEPA-approved QAPP as well as allow for sufficient time to conduct necessary pre-mobilization activities. If USEPA determines that RM 10.9 capping efforts will extend into early June please notify Tierra accordingly.

University of Illinois

Department of Geology
Computer Applications Building
605 East Springfield Avenue
Champaign
Illinois 61820

Statement of Work for River Mile 10.9 Pipeline Survey: Parametric Echo Sounding and Ground Penetrating Radar

April 2014

Revision 1

Prepared For:
Maxus Energy Corporation
Tierra Solutions, Inc.

Prepared By:
Professor James Best
Threet Professor of Sedimentary Geology
University of Illinois

Introduction

The University of Illinois, Department of Geology (UoI), was contracted by Maxus Energy Corporation and Tierra Solutions to conduct a field survey for identifying the horizontal and vertical location of two, 72-inch diameter, water pipelines running across the Passaic River, near River Mile 10.9 (RM10.9). UoI's survey group has extensive experience utilizing Parametric Echo Sounding and Ground Penetrating Radar to detect the subsurface structure of alluvial sediments and in this Statement of Work (SOW) UoI outlines the methodological approaches and survey procedures required in order to assist in this pipeline detection. This SOW provides an overview of the techniques, the survey to be conducted and an estimated timetable.

Scope and Purpose of the Survey

The survey will aim to locate the horizontal and vertical position of two, 72-inch diameter, water pipes running across the Passaic River at approximately RM 10.9 (Figure 1) within the current no-dredge zone. A boat-based Parametric Echo Sounder (PES) survey will aim to locate the pipelines within the channel and no-dredge zone, whilst a land-based Ground Penetrating Radar (GPR) survey will aim to locate their position on the south side of the river in the exposed intertidal area and dry land at the adjacent park. This survey will aim to assist in location of the pipes within the no-dredge zone and use the position of the pipes outside this zone to help delineate their trend and position. The PES survey in the deeper water of the river channel will potentially allow greater penetration of the acoustic signal into the subsurface and aid in detection of the pipeline position and orientation.

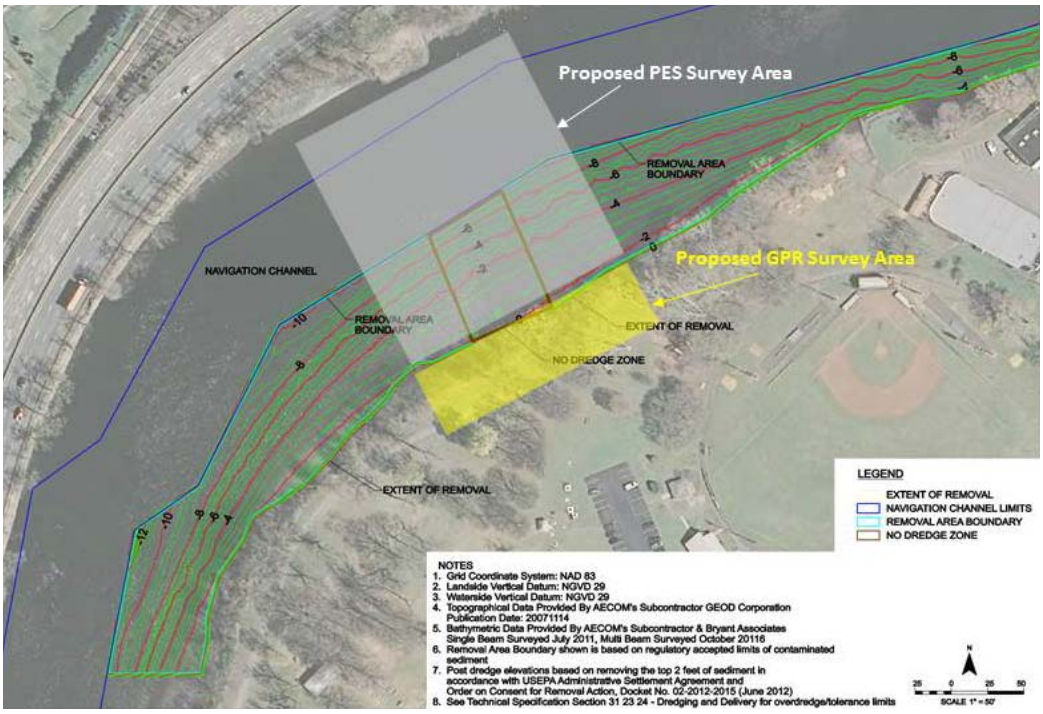


Figure 1: Location of the no-dredge zone at River Mile 10.9 and the proposed area for the PES survey (grey rectangle) and GPR survey (yellow rectangle). Base image taken from Passaic River Dredging Design Engineered Plan Appendix D.

Parametric Echo Sounding

Parametric Echo Sounding (PES) has been developed over the last 15 years, firstly as a marine tool to provide high-resolution subsurface images of fine-grained deposits (Wunderlich and Muller, 2003). The key difference of the PES over traditional linear subsurface profiling systems is that it transmits two slightly different high frequency signals, which interact to generate new frequencies (the sum and the difference of the initial signals). The sum, high frequency, signal provides data on depth in the same way as normal linear echosounders. Additionally, the difference of the transmitted frequencies provides a low frequency signal capable of penetrating the subsurface to provide data on the sedimentary stratigraphy and buried objects. The PES has thus proved a popular tool amongst the oceanographic community in a wide range of applications. However, *four aspects of the PES capabilities make it uniquely suited to applications investigating fine-grained shallow-water environments*. First, due to the high system bandwidth of the PES, very short signals can be transmitted without ringing, meaning that PES can be used in shallow waters (i.e. depths of ~1meter (m)) and thus may be of great utility in rivers. Secondly, the small beam width and high frequency bandwidth result in echoes with steep slopes that can detect small changes of acoustic impedance, thus yielding high-resolution (i.e. decimeter) imaging, ideally suited to the study of river environments. Thirdly, the transmit directivity of the parametric sound beam does not show any significant side lobe characteristics, which reduces ambiguities during the interpretation of individual reflectors. Fourthly, the PES is very easy to deploy, consisting of a single transducer that is mounted to the hull of a boat. Other high-resolution seismic systems, such as Chirp or Boomer, commonly are deployed from catamarans or towed fish, which makes them difficult to tow and deploy in shallow water. Use of this PES technology in the Passaic River would thus be innovative in comparison to past subbottom profiler surveys that achieved limited penetration and resolution due to the consolidated nature of the muds. PES is potentially ideally suited to finer-grained sediments in shallow waters.

The PES to be used in this survey is an Innomar SES-2000 Light, which employs a primary frequency of 100 kHz, with a selectable lower frequency of 4,5,6,8,10,12 or 15 kHz. The PES can be deployed in a water depth range of 1-400m, with a maximum vertical resolution of 0.05m and a horizontal resolution of ±2% of the acoustic footprint. The PES can ping at up to 50Hz, and thus the horizontal spacing of the data is determined by the selected ping rate and vessel speed.

Data acquisition is digital 24bit, and both the envelope data as well as full waveform data are collected, allowing full waveform post-processing. The Innomar SES2000 thus represents a state-of-the-art technique for the high-resolution quantification of subsurface structure in shallow water environments, and has the potential to greatly assist in detection of the water pipelines at River Mile 10.9 as well as subsurface quantification of sediments in the Passaic River. It should be noted, however, that the presence of any gas in the sediments at the survey site could make acoustic penetration impossible.

Vessel heave is accounted for by use of an ORE Offshore Motion Reference Unit (MRU) that is mounted to the PES survey pole. This MRU allows any vertical displacements due to heave to be taken out of the data collected at the time of survey.

An example of PES output collected from a previous survey conducted over a sandy river bed is given in Figure 2. This river was predominantly sand bed but did contain a small percentage of finer-grained material that aided the acoustic penetration of the PES. This data shows a downstream section across a series of sand dunes and reveals: i) the accurate bed morphology that can be detected, and ii) the extremely fine detail of the subsurface sedimentary structure that can be revealed. A full description of this data set and its geological use is given in Sambrook Smith et al. (2013).

A second example of PES output has been supplied by Innomar (Figure 3) and illustrates its use for pipe detection, and clearly shows the hyperbolic signal produced by the pipe from the PES survey. It should be noted that this PES data shows the waveform envelope data, and not the full waveform data that will be collected in the Passaic River Mile 10.9 Pipeline Survey, with the latter being able to show more detail of the subsurface sediment structure.

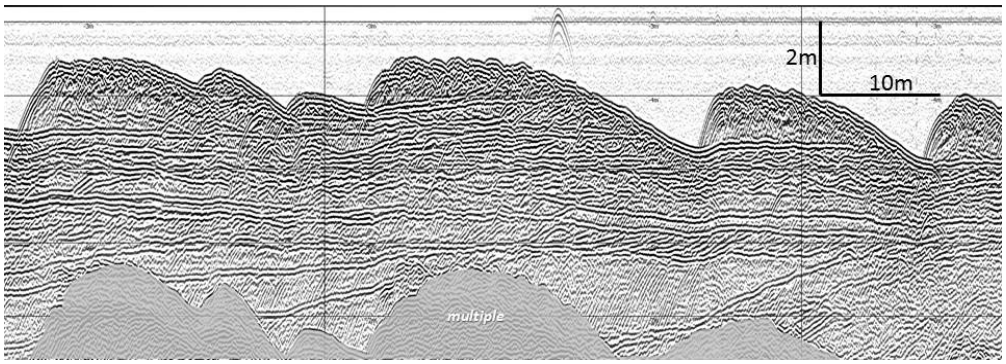


Figure 2: Example of PES output from the sandy-silty Río Paraná, Argentina. Profile shows section along a series of sand dunes (flow right to left) in a flow depth of~ 3.5m, and reveals high-resolution imaging of the subsurface structure to a depth of 3.5m into the sediments. Note the fine detail of the sedimentary surfaces within the subsurface that are produced by the migrating dunes and caused by differences in grain type within these sand-silt sediments (see Sambrook Smith et al. (2013) for a full description of this dataset).

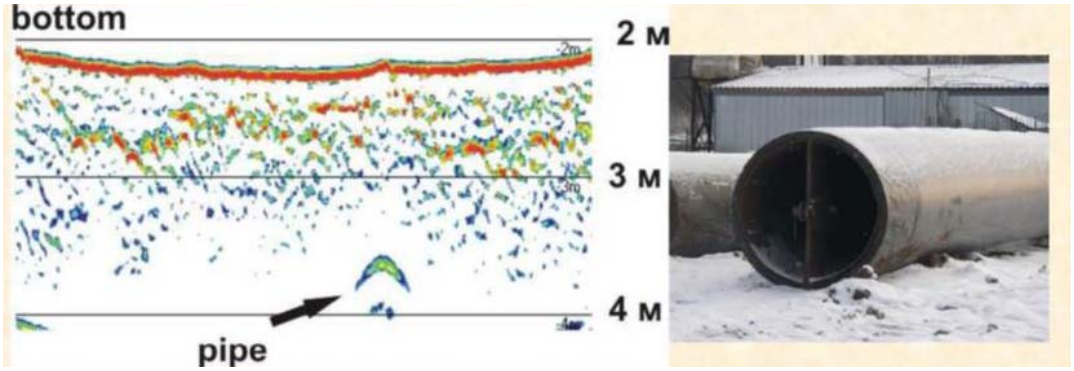


Figure 3: Example of PES output for pipe detection in a river bed under ~1.8m of sediment. Note the clear hyperbolic reflection of the pipe generated by the PES. Image courtesy of Innomar Technologie GmbH.

Ground Penetrating Radar

Ground-penetrating radar (GPR) is a technique that uses high-frequency electromagnetic waves to provide high-resolution imaging of the subsurface. GPR has been extensively used in the past for target detection (e.g. utilities, pipes, barrels, drums, archaeological artifacts) as well as characterizing the subsurface stratigraphy of sediments and the water table in geotechnical and hydrological applications. GPR works by transmitting low-power microwave energy into the ground from antennae that transmit at frequencies ranging from 10MHz to 3 GHz. The choice of frequencies used is dictated by ground conditions and the resolution required, with higher frequency GPR producing greater vertical resolution but having a lower penetration into the subsurface. The GPR signal is reflected back to the antennae from materials in the subsurface with contrasting electrical impedance, which is determined by the dielectric permittivity characteristics of the sediments, their conductivity, magnetic permeability and physical properties. Larger contrasts in the dielectric permittivity of the two materials produce a larger amplitude reflection. Such differences may be generated by differences in material, such as a buried pipe, or in natural sediments by changes in grain type, mineralogy and water content. It is worthy of note that fine-grained materials, such as clay, severely attenuate the EM signal and may produce no penetration, whilst saline water allows no GPS signal due to the conductivity of the surface water and porewater. Any saline porewater may cause little or no penetration of the GPR signal at the Passaic River Mile 10.9 survey site.

An example of GPR data from our previous work on sand-bed rivers is shown in Figure 4, and reveals the excellent detail that may be obtained, at a decimeter vertical resolution.

In the Passaic River Mile 10.9 survey, UoI proposes use of a Sensors and Software pulseEKKO Pro GPR system with 100 and 200 MHz antennae, and possibly a pulseEKKO Noggin with 250 MHz antennae. Both of these systems are deployed from a SmartCart that allows easy and rapid survey, and both will be linked into the dGPS location (see below).

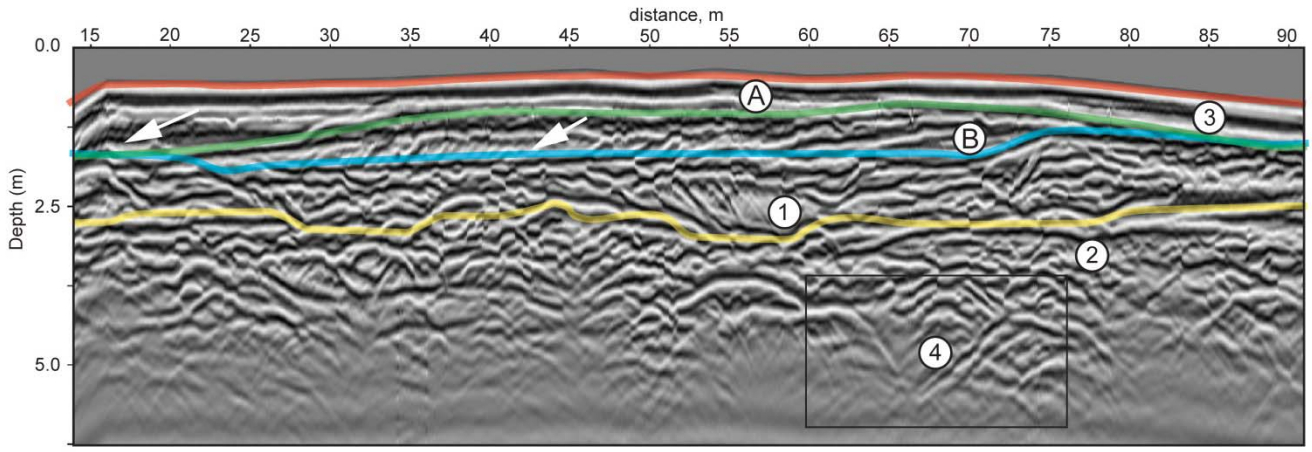


Figure 4: Example of GPR output for studying the subsurface structure of sediments in a sandy braided river. Figure taken from Lunt et al. (2013). In this figure, the green and blue lines represent the surfaces of sand bars measured in previous years, with the yellow line denoting the basal erosion surface produced by the contemporary channel. The labels A and B refer to deposits of the most recent sand bars that occupied this site. Numbers 1-4 define the various sedimentary units that could be classified using the nature of the GPR reflections, including stratification from sand bars (1), sand dunes (2) and small erosive channels (4).

Real-time Kinematic Differential GPS

All locations will be ascertained using a Leica System GX 1230 real-time kinematic differential GPS. This system uses a ground base station to achieve location accuracies of ~0.03m in horizontal position and~ 0.05m in the vertical. UoI will tie these data into 3 local benchmarks .

Survey Proposal and Timetable

This SOW proposes a 3-day survey of the study area that will allow meeting with a new Jersey Professional Land Surveyor (PLS) (see below), deployment of the equipment and collection of high-density data to assist in pipeline detection (see proposed survey areas in Figure 1).

PES

Day 1 will involve deployment of the survey vessel and optimization of the PES operating frequency for obtaining the highest resolution data. This optimization will be conducted at several places along the Passaic River in order to encompass the range of sediments that may be present (differing grain sizes and types), as well as ascertain the presence of any gas in the sediments that would obliterate the PES signal. If successful, Day 2 will then entail a detailed survey of the pipeline crossing area at River Mile 10.9. In order to gain maximum penetration into the subsurface, work will be conducted at the highest water levels (at high tide and also moderate-high river discharges if possible). A line spacing of ~5m in lines parallel to the river edge along river (the river is ~120m wide at this point) will be employed, thus producing ~24, 50m long lines within the study area. Further, 5-10 flow-transverse lines across river will be surveyed in the vicinity of the pipelines in order to provide cross-stream correlation of the subsurface images, and assist in delineating the trend of the pipeline. These line spacings along and across river will allow detection of the pipe at several points (~24-30) across channel and within the no-dredge zone, whilst providing a time schedule that can be achieved in the two-day survey period. The PES survey in the deeper water of the river channel will potentially allow greater penetration of the acoustic signal into the subsurface and aid in detection of the pipeline position and orientation. This survey will produce ~2.4km of PES lines that will be used to constrain the pipeline position.

GPR

Day 1 will comprise testing of the GPR on the south side of the river in the adjacent park, and will involve testing several different frequency antennae to determine whether or not saline groundwater may cause penetration issues, and if not, which frequency of antennae allows for the best penetration and GPR resolution in the soil/sediment present (both in the park and intertidal areas). If successful in deployment, Day 1 will also be used to find horizontal reflectors in the subsurface that can be used to conduct an offset survey to be used in later Common MidPoint (CMP) analysis that will establish the speed of EM wave propagation in these sediments, which is essential for assessment of the depth of pipeline burial. The remainder of Day 1 and Day 2 will then be used to run lines parallel to the river bank and ~50m long to detect pipeline position. Five, 50m long, lines will be run in the park adjacent to the pipeline crossing, with a 4m spacing. This will yield ~300 m of GPR lines. This line spacing will allow detection of the pipe at several points on land that can be linked to the results from the PES survey, whilst providing a time schedule that can be achieved in the two-day survey period. A line will be run in the intertidal area if water levels permit, to provide an additional cross-point for pipeline tracing. Any work conducted in the intertidal area will be dependent on suitable water levels and only if health and safety issues can be satisfactorily addressed in accessing and working in the intertidal region. Additional lines across the survey area, perpendicular and at angles to the principal survey lines, will also be run dependent on the subsurface detection gained.

Survey Procedure

A small aluminum survey vessel will be launched from a public boat slip on the Passaic River for the PES survey. This vessel has a shallow draft, thus allowing access to shallow water, and the PES transducer is deployed off a mount near the bow of the boat. The GPS antennae is fixed to the top of the PES mounting pole, together with the motion reference unit, and the GPS base station will be established on Day 1 over a temporary benchmark in the nearby park on the south side of the river. This benchmark will then be tied into local established benchmarks for later post-processing of exact positions, with this work also being conducted on Day 1 of the survey. The PES processor will be housed in a waterproof enclosure on the boat and power will be provided by a Honda 1000W quiet-running generator. PES surveys will take place as near to high tide as possible in order to maximize possible depth of penetration, with possible GPR surveys on the intertidal mudflat at low tide. GPR surveys in the

adjacent park will be conducted at high tide to maximize time efficiency.

The GPR will be deployed from SmartCarts that can be easily used in the gentle terrain of the riverside park as well as pushed over soft sediments in the intertidal zone.

The UoI will implement, upon QA/QC verification, the system of available and present benchmarks. If these benchmarks are not available, or do not pass survey specification standards, a New Jersey PLS will be contracted to establish a series of benchmarks (3) along the survey corridor. Poor satellite visibility will be managed by conducting the bulk of the survey efforts when satellite constellation configurations will be at their peak or best, depending on the periods of high tidal flow (high tides in early June 2014 are around midday when satellite constellations are also often at their optimum).

Time Schedule, Delivery of Data and Final Report

The PES and GPR data will require post-processing to allow removal of artifacts, application of filters to the data in order to allow optimization of the final results and application of sound velocity data to determine the sediment thicknesses. Likewise, the GPS data may require post-processing to ensure maximum accuracy of the geolocation for the PES and GPR lines. UoI will provide estimation of the accuracy of the surveys and the errors involved to constrain the accuracy of detection of the pipeline. Data analysis and final reporting is anticipated to be complete within approximately 6 weeks post completion of the field survey. Table 1 summarizes the estimated timetable for the survey and delivery of draft report. Field work has tentatively been scheduled for the week of June 2nd 2014.

Access and Notice

Bergen County Parks Department will be notified of the need to access the shoreline as well as the availability of an emergency boat launch with the Lyndhurst Fire Department before the survey efforts commence. Rivers users, such as local township high school rowing crews and boating clubs, will be informed of the survey schedule once it is finalized.

Week	1	2	3	4	5	6	7	8	9	10	11	12
EPA notice to proceed	*Day 0*											
Equipment procurement, preparation of equipment for field deployment												
Mobilisation of boat & equipment from UoI to field site and establishment of survey benchmark												
Field Survey (2 days)						*2 days*						
Demobilisation of boat & equipment and travel back to UoI												
Data Processing												
Report Preparation												
Issuance of Draft Report to EPA												

Table 1: Estimated timetable for survey. Note that precise survey dates in the field will be dependent on weather and tidal conditions and availability of equipment.

Enclosures:
Manufacturers Details for:

1) Innomar SES-2000 Light Parametric Echo Sounder
2) Leica GX 1230 GPS and Pacific Crest radio modems
3) ORE Offshore Motion Reference Unit
4) Sensors and Software pulseEKKO PRO ground penetrating radar
5) Sensors and Software pulseEKKO NOGGIN ground penetrating radar

References Cited

Lunt, I.A., Ashworth, P.J., Best, J.L., Bridge, J.S., Lane, S.N., Sambrook Smith, G.H., Simpson, C.J., and Thomas, R.E. 2013 Deposits of the sandy braided South Saskatchewan river: Implications for the use of modern analogs in reconstructing channel dimensions in reservoir characterization, *Bulletin American Association of Petroleum Geologists,* 97, 553-576.

Passaic River Dredging Design Engineered Plan, 2012 *Appendix D*. CH2M Hill, 28pp.

Sambrook Smith, G.H., Best, J.L., Orfeo, O., Vardy, M.E. and Zinger, J.A., 2013 Decimeter-scale in situ mapping of modern cross-bedded dune deposits using parametric echo sounding (PES): a new method for linking river processes and their deposits, *Geophysical Research Letters.*, 40, 3883-3887, DOI: 10.1002/grl.50703.

Wunderlich, J. and Muller, S. 2003 High-resolution subbottom profiling using parametric acoustics. *International Ocean Systems*, 7, 6-11.

SES-2000 light

Parametric Sub-bottom Profiler

Performance
- water depth range: 0 – 400 m
- penetration: up to 40 m depending on sediments and frequency
- range resolution: up to 5 cm, depending on pulse settings
- HRP compensation: heave, depending on sensor data
- beam width @ 3 dB: ± 2° / footprint < 7 % of water depth for all frequencies

Transmitter
- primary high frequencies: 94 – 110 kHz
- secondary low frequencies: 5, 6, 8, 10, 12, 15 kHz
- primary pulse power: > 12 kW
- primary source level: > 236 dB//µPa re 1 m
- pulse width: 0.07 – 1 ms
- pulse rate: up to 50/s depending on range, multi-ping mode available
- pulse type: CW, Ricker

Receiver
- primary high frequency (echo sounder, bottom track)
- secondary low frequency (sub-bottom data, multi-frequency mode)
- water column imaging

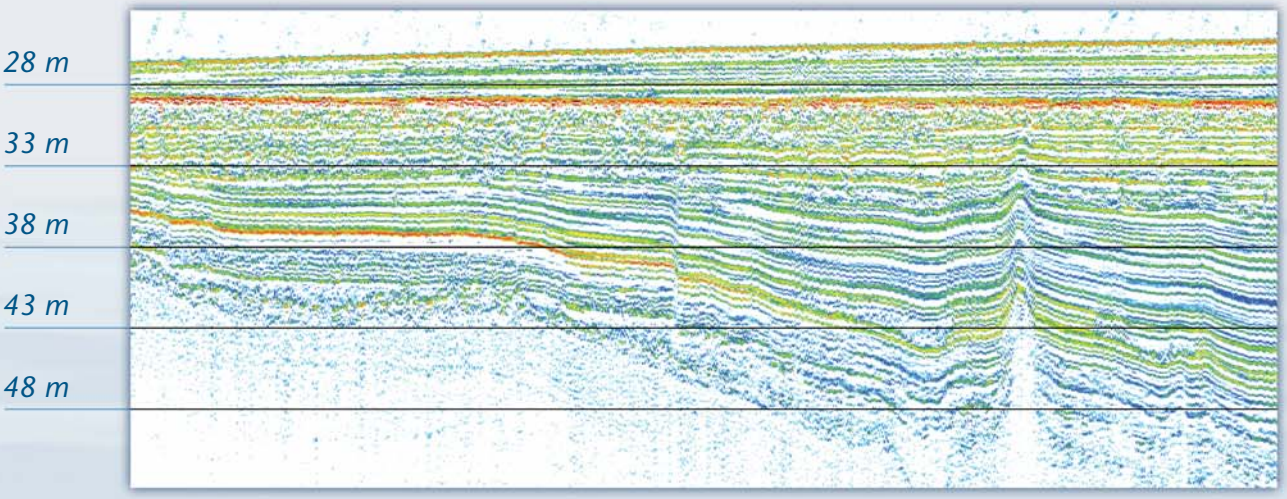
System Components
- transceiver unit 19 inch / 7 U (WHD: 0.52 m x 0.35 m x 0.40 m; 35 kg)
- transducer incl. 20 m cable (WHD: 0.34 m x 0.08 m x 0.26 m; 22 kg)
- system control: internal PC

Software
- SESWIN data acquisition software
- SES Convert SEG-Y/XTF data export
- SES NetView remote display
- ISE post-processing software

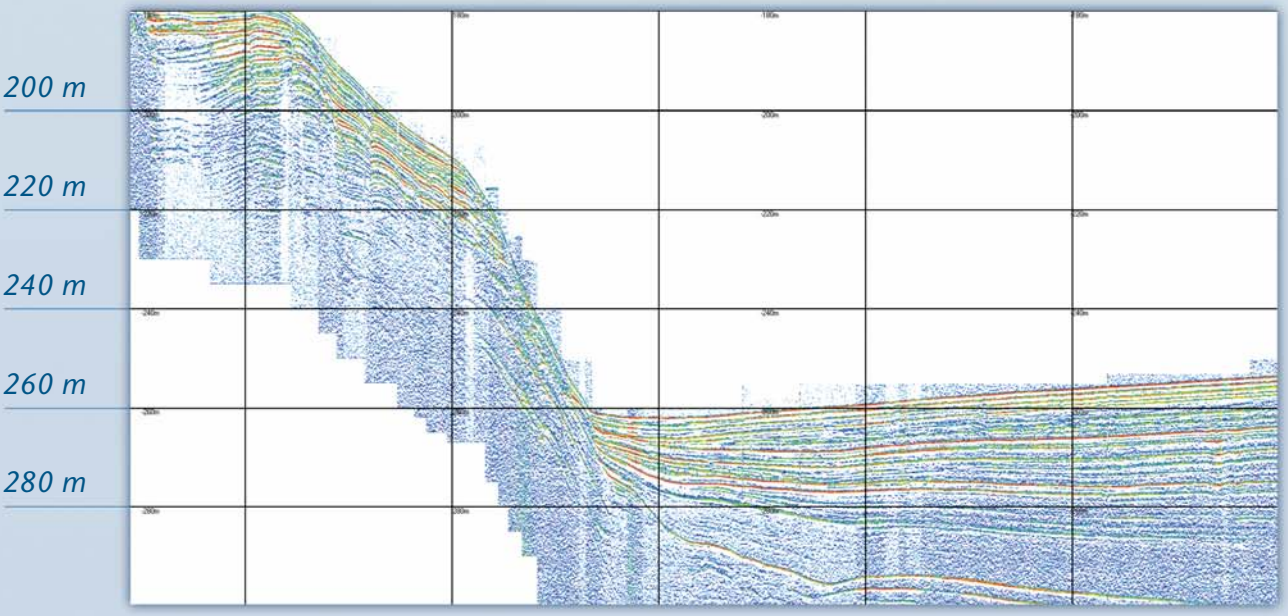
Power Supply Requirements
- 100 – 240 V AC / 50 – 60 Hz
- power consumption: < 350 W

Innomar
www.innomar.com
Innomar Technologie GmbH, Germany

Survey examples of SES-2000 light



Baltic Sea echo plot example *– Frequency 8kHz, pulse length 375µs, profile length 4000m*



Lake Ohrid (Macedonia) echo plot example *– Frequency 10kHz, pulse length 500µs, profile length 5500m*

Innomar Technologie GmbH

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E-Mail info@innomar.com

Innomar

www.innomar.com

Leica GPS1200 Series
Technical Data

GNSS
future proof

- when it has to be **right**

Leica Geosystems

GPS1200 Technical Data

For reference station products please refer to the technical data for GRX1200 series receivers (746097)

Summary Description

	GX1230 GG / ATX1230 GG	GX1230 / ATX1230	GX1220	GX1210
Receiver type	Dual-frequency, GNSS, geodetic, real- time RTK receiver	Dual-frequency, GPS only, geodetic, real-time RTK receiver	Dual-frequency, GPS only, geodetic receiver	Single-frequency, GPS only, survey receiver
Summary of measuring, modes and applications	Static, rapid static, kinematic On the fly L1 + L2, code, phase Real-time RTK standard Post processing DGPS/RTCM standard Survey, geodetic and real-time RTK applications	Static, rapid static, kinematic On the fly L1 + L2, code, phase Real-time RTK standard Post processing DGPS/RTCM standard Survey, geodetic and real- time RTK applications	Static, rapid static, kinematic On the fly L1 + L2, code, phase Post processing DGPS/RTCM optional Survey and geodetic applications	Static, kinematic L1, code, phase DGPS/RTCM optional Survey and GIS applications

System Components

Receiver

	GX1230 GG / ATX1230 GG	GX1230 / ATX1230	GX1220	GX1210
Receiver technology	SmartTrack+ is built on SmartTrack technology and enhanced for GNSS signals. Code and phase multipath mitigation.	SmartTrack – patented. Discrete elliptical filters. Fast acquisition. Strong signal. Low noise. Excellent tracking, even to low satellites and in adverse conditions. Interference resistant. Code multipath mitigation.		
L5 and GALILEO prepared	Yes	No	No	No
No. of channels	72 channels 14 L1 + 14 L2 GPS 2 SBAS 12 L1 + 12 L2 GLONASS	12 L1 + 12 L2 2 SBAS	12 L1 + 12 L2 2 SBAS (with DGPS option)	12 L1 2 SBAS (with DGPS option)
L1 measurements (GPS)	Carrier phase full wave length C/A narrow code	Carrier phase full wave length C/A narrow code	Carrier phase full wave length C/A narrow code	Carrier phase full wave length C/A narrow code
L2 measurements (GPS)	Carrier phase full wave length with C-code and P-code (AS off) or P-code aided under AS Equal performance with AS off or on	Carrier phase full wave length with P-code (AS off) or P-code aided under AS Equal performance with AS off or on	Carrier phase full wave length with P-code (AS off) or P-code aided under AS Equal performance with AS off or on	No

L1 measurements (GLONASSS)	Carrier phase full wave length C/A narrow code	No	No	No
L2 measurements (GLONASS)	Carrier phase full wave length P narrow code	No	No	No
Independent measurements	Fully independent L1 and L2 code and phase measurements	Fully independent L1 and L2 code and phase measurements	Fully independent L1 and L2 code and phase measurements	Fully independent L1 code and phase measurements
Time to first phase measurement after switching ON	Typically 30 secs	Typically 30 secs	Typically 30 secs	Typically 30 secs

Receiver Housing

	ATX1230 GG / ATX1230	GX1230 GG / GX1230 / GX1220 / GX1210
LED status indicators	3: for power, tracking, Bluetooth	3: for power, tracking, memory
Ports	1 RS232 clip-on port 1 USB port	4 RS232 port 1 Power only port 1 TNC port for antenna 1 PPS, 2 Event port optional
Supply voltage Power consumption	Nominal 12V DC Range 10.5-28V DC Typically 1.8W, 270mA	Nominal 12V DC Range 10.5-28V DC Typically 3.2W, 270mA
Dimensions	186mmX89mm	0.212m x 0.166m x 0.079m (The dimensions are given for the housing without the sockets)
Weight, receiver only	1.12kg	1.2kg

GPS Antennas

	GX1230 GG	GX1220 / GX1230	GX1210
Standard survey antenna	**AX1202 GG, L1/L2 SmartTrack+**	**AX1202 GG, L1/L2 SmartTrack+**	**AX1201, L1 SmartTrack**
Groundplane Dimensions (diameter x height) Weight	Built-in groundplane 170mm x 62mm 0.44kg	Built-in groundplane 170mm x 62mm 0.44kg	Built-in groundplane 170mm x 62mm 0.44kg
Choke-ring antenna	**AT504 choke-ring, L1/L2 microstrip. (GPS only)**	**AT504 choke-ring, L1/L2 microstrip. (GPS only)**	**No**
Design Protection radome Dimensions:diameter x ht Weight	Dorne Margolin, JPL design. optional 380mm x 140mm (antenna) 4.3kg (antenna)	Dorne Margolin,JPL design. optional 380mm x 140mm (antenna) 4.3kg (antenna)	

SmartAntenna

	ATX1230 GG	ATX1230
Standard survey antenna	**ATX1202 GG, L1/L2 SmartTrack+**	**ATX1230, L1/L2 SmartTrack**
Groundplane	Built-in groundplane	Built-in groundplane
Dimensions (diameter x height)	186mmX89mm	186mmX89mm
Weight	1,12kg	1,12kg

Controller

	ATX1230 GG / ATX1230 GX1230 GG / GX1230 GX1220 GX1210
Type	RX1210, RX1210T (with touch screen) for GX1230 GG/GX1230/GX1220/GX1210 RX1250 (with touch screen) for ATX1230 GG/ATX1230
Display	¼ VGA, monochrome, graphics capable, illumination
Character Set	Maximum 256 characters, extended ASCII characters set
Touch screen (RX1210T only)	Toughened film on glass
Keyboard	Full alphanumeric (62 keys), 12 function keys, 6 user-definable keys, illumination
Controller Weights	RX1210 0.48kg RX1250 0.75kg
Total Weights of System	SmartRover 2.79kg (all on the pole) GX1200 Rover 4.15kg (all on the pole) GX1200 Rover 1.80kg (weight of pole for Minipack setup)

Measurement Precision and Position Accuracies

	GX1230 /ATX1230	GX1220	GX1210
Important Note	Measurement precision and accuracy in position and accuracy in height are dependent upon various factors including number of satellites, geometry, observation time, ephemeris accuracy, ionospheric conditions, multipath etc. Figures quoted assume normal to favourable conditions. Times can also not be quoted exactly. Times required are dependent upon various factors including number of satellites, geometry, ionospheric conditions, multipath etc. GPS and GLONASS can increase performance and accuracy by up to 30% relative to GPS only. The following accuracies, given as **r**oot **m**ean **s**quare, are based on measurements processed using LGO and on real-time measurements.		

Code and Phase Measurement Precision (irrespective whether AS off/on)

	ATX1230 GG / ATX1230 / GX1230 GG / GX1230	GX1220	GX1210
Carrier phase on L1	0.2mm rms	0.2mm rms	0.2mm rms
Carrier phase on L2	0.2mm rms	0.2mm rms	
Code (pseudorange) on L1	2cm rms	2cm rms	2cm rms
Code (pseudorange) on L2	2cm rms	2cm rms	

Accuracy (rms) with post processing

	ATX1230 GG / GX1230 GG / GX1230 / ATX1230	GX1220	GX1210
	With LEICA Geo Office L1/L2 processing software. GLONASS processing option also needed to process GLONASS data	With LEICA Geo Office L1/L2 processing software	With LEICA Geo Office L1 processing software
Static (phase), long lines, long observations, choke ring antenna	Horizontal: 3mm + 0.5ppm Vertical: 6mm + 0.5ppm	Horizontal: 3mm + 0.5ppm Vertical: 6mm + 0.5ppm	Not applicable
Static and rapid static (phase) with standard antenna)	Horizontal: 5mm + 0.5ppm Vertical: 10mm + 0.5ppm	Horizontal: 5mm + 0.5ppm Vertical: 10mm + 0.5ppm	Horizontal: 10mm + 1ppm Vertical: 20mm + 2ppm
Kinematic (phase), in moving mode after initialization	Horizontal: 10mm + 1ppm Vertical: 20mm + 1ppm	Horizontal: 10mm + 1ppm Vertical: 20mm + 1ppm	Horizontal: 20mm + 2ppm
Code only	Typically 25cm	Typically 25cm	Typically 30cm

Accuracy (rms) with real-time/RTK

	ATX1230 GG / ATX1230 / GX1230 GG / GX1230	GX1220	GX1210
RTK capability	Yes, standard	No	No
Rapid static (phase), Static mode after initialization	Horiz: 5mm + 0.5ppm Vertical: 10mm + 0.5ppm		
Kinematic (phase), moving mode after initialization	Horiz: 10mm + 1ppm Vertical: 20mm + 1ppm		
Code only	Typically 25cm		

Accuracy (rms) with DGPS/RTCM

	ATX1230 GG / ATX1230 / GX1230 GG / GX1230	GX1220	GX1210
	DGPS/RTCM standard	DGPS/RTCM optional	DGPS/RTCM optional
DGPS/RTCM	Typically 25cm (rms)	Typically 25cm (rms)	Typically 30cm (rms)

Accuracy (rms) in single receiver navigation mode

	ATX1230 GG / ATX1230 / GX1230 GG / GX1230	GX1220	GX1210
Navigation accuracy	5–10m rms for each coordinate	5–10m rms for each coordinate	5–10m rms for each coordinate
Degradation effect	Degradation possible due to SA	Degradation possible due to SA	Degradation possible due to SA

On-the-Fly (OTF) initialisation

	ATX1230 GG / ATX1230 / GX1230 GG / GX1230	GX1220	GX1210
OTF Capability	Real time and post processing	Post processing only	No OTF
Reliability of OTF initialisation	Better than 99.99%	Not applicable	Not applicable
Time for OTF initialisation	Typically 8secs, with 5 or more satellites on L1 and L2	Not applicable	Not applicable
OTF Range*	Typically up to 30km in normal conditions	Not applicable	Not applicable
*Assuming reliable data-link is available in RTK case	Up to 40km in favorable conditions.	Not applicable	

Position update and latency

	ATX1230 GG / ATX1230 / GX1230 GG / GX1230	GX1220	GX1210
	RTK and DGPS standard	DGPS optional	DGPS optional
Position update rate	Selectable: 0.05 sec (20Hz) to 60 secs	Selectable: 0.05 sec (20Hz) to 60 secs	Selectable: 0.05 sec (20Hz) to 60 secs
Position latency	0.03 sec or less	0.03 sec or less	0.03 sec or less

Real-time RTK and DGPS/RTCM Data Formats

	ATX1230 GG / ATX1230 / GX1230 GG / GX1230	GX1220	GX1210
	Real-time RTK standard DGPS/RTCM standard	DGPS/RTCM optional	DGPS/RTCM optional
RTK Data Formats for data transmission and reception	Leica proprietary format. CMR, CMR+		
RTCM Format for data transmission and reception	RTCM Versions 2.x supporting messages 1,2,3,9,18,19,20,21,22,23,24 And RTCM Version 3	RTCM Versions 2.x supporting messages 1,2,3,9,18,19,20,21,22,23,24 And RTCM Version 3	RTCM Versions 2.x supporting messages 1,2,3,9 And RTCM Version 3
Simultaneous transmissions	2 real time output interfaces via independent ports, providing identical or different RTK/RTCM formats		

Data recording

Recording rate	Selectable from 0.05 to 300 s
Standard medium	CompactFlash cards: 64MB, 256 MB, 1GB
Optional medium	Internal memory for receiver: 256 MB
Data capacity:	64 MB is sufficient for about ▪ 1100h L1 + L2 data logging at 15s rate ▪ 4400h L1 + L2 data logging at 60s rate ▪ 90'000 real-time points with codes

Power supply for GX1200 receivers

Internal battery	GEB221 rechargeable Li-Ion battery 3.8Ah/7.2V, 2 batteries fit into receiver
Operation time	2 GEB221 power GX1200 receiver plus antenna plus RX1200 Controller for about 15h
Weight, GEB221 battery	0.2kg
External battery, optional	GEB171 7Ah/12V NiMh battery
Operation time	1 GEB171 powers GX1200 receivers plus antenna plus RX1200 Controller for about 30h

Power supply for SmartRovers

Internal battery	GEB211 rechargeable Li-Ion battery 1.9Ah/7.2V, 1 battery fits into ATX1230 and 1 battery fits into RX1250
Operation time	1 GEB211 powers ATX1230 for about 5h 1 GEB211 powers RX1250 for about 11h
Weight, GEB211 battery	0.11kg

Operation of GX1200 receivers with and without controller

Manual operation with RX1210 Controller	Standard method. Receiver control, operation, data input, survey-data acquisition, information display via controller
Automatic operation without Controller	Automatic on switching on. Modes and parameters for receiver operation, measuring, recording, transmission etc preset using controller
LED	3 LED's indicate power, tracking, memory
Manual operation with RX1220 Controller	As an alternative the total station remote control unit RX1220 can be used for manual operation of the sensor in exactly the same way as the RX1210

Operation of SmartRovers with and without controller

An RX1250 Controller is always required to operate an ATX1230

Navigation mode

Navigation	Full navigation information in position and stakeout displays Position, course, speed, bearing and distance to waypoint

Environmental specifications

Receivers	**Valid for GX1210, GX1220, GX1230, GX1230 GG, ATX1230, ATX1230 GG**
Temperature, operating	-40°C to +65°C* Compliance with ISO9022-10-08, ISO9022-11-special and MIL-STD-810F Method 502.4-II, MIL-STD-810F Method 501.4-II *Bluetooth: -30°C to +60°
Temperature, storage	-40°C to +80°C Compliance with ISO9022-10-08, ISO9022-11-special and MIL-STD-810F Method 502.4-I, MIL-STD-810F Method 501.4-I
Humidity	Up to 100%* Compliance with ISO9022-13-06, ISO9022-12-04 and MIL-STD-810F Method 507.4-I * The effects of condensation are to be effectively counteracted by periodically drying out the product
Protection against Water, Sand and Dust	IP67 Protection against blowing rain Waterproof to temporary submersion into water (maximum depth of 1m) Dust-tight, protection against blowing dust Compliance with IP67 according IEC60529 and MIL-STD-810F Method 506.4-I, MIL-STD-810F Method 510.4-I, MIL-STD-810F Method 512.4-I
Drops	Withstands 1m drop onto hard surfaces
Vibration	Withstands vibrations during operation on large civil construction machines Compliance with ISO9022-36-08 and MIL-STD-810F Method 514.5-Cat24
Functional Shock	No loss of lock to satellite signal when used on a pole set-up and submitted to pole bumps up to 150mm

GPS Antennas	Valid for AX1201, AX1202GG
Temperature, operating	-40°C to +70°C Compliance with ISO9022-10-08, ISO9022-11-05 and MIL-STD-810F Method 502.4-II, MIL-STD-810F Method 501.4-II
Temperature, storage	-55°C to +85°C Compliance with ISO9022-10-09, ISO9022-11-06 and MIL-STD-810F Method 502.4-I, MIL-STD-810F Method 501.4-I
Humidity	Up to 100%* Compliance with ISO9022-13-06, ISO9022-12-04 and MIL-STD-810F Method 507.4-I * The effects of condensation are to be effectively counteracted by periodically drying out the product
Protection against Water, Sand and Dust	IP66, IP67 Protection against water jets Protection against blowing rain Waterproof to temporary submersion into water (maximum depth of 1m) Dust-tight, protection against blowing dust Compliance with IP66 and IP67 according IEC60529 and MIL-STD-810F Method 506.4-I, MIL-STD-810F Method 510.4-I, MIL-STD-810F Method 512.4-I
Drops Vibration	Withstands 1.5m drop onto hard surfaces Withstands vibrations during operation on large civil construction machines Compliance with ISO9022-36-08 and MIL-STD-810F Method 514.5-Cat24
Functional Shock	No loss of lock to satellite signal when used on a pole set-up and submitted to pole bumps up to 150mm
Topple over pole	Survives topple over from a 2m survey pole onto hard wood on a concrete floor
Controller	**Valid for RX1210, RX1210T and RX1250 controllers**
Temperature, operating	-30°C to +65°C Compliance with ISO9022-10-06, ISO9022-11-special and MIL-STD-810F Method 502.4-II, MIL-STD-810F Method 501.4-II
Temperature, storage	-40°C to +80°C Compliance with ISO9022-10-08, ISO9022-11-special and MIL-STD-810F Method 502.4-I, MIL-STD-810F Method 501.4-I
Humidity	Up to 100%* Compliance with ISO9022-13-06, ISO9022-12-04 and MIL-STD-810F Method 507.4-I * The effects of condensation are to be effectively counteracted by periodically drying out the product
Protection against Water, Sand and Dust	IP67 Protection against blowing rain Waterproof to temporary submersion into water (maximum depth of 1m) Dust-tight, protection against blowing dust Compliance with IP67 according IEC60529 and MIL-STD-810F Method 506.4-I, MIL-STD-810F Method 510.4-I, MIL-STD-810F Method 512.4-I
Drops Vibration	Withstands 1.5m drop onto hard surfaces Withstands vibrations during operation on large civil construction machines Compliance with ISO9022-36-08 and MIL-STD-810F Method 514.5-Cat24

Communication Module	Valid for all Leica GFU based communication modules
Humidity	Up to 100%* Compliance with ISO9022-13-06, ISO9022-12-04 * The effects of condensation are to be effectively counteracted by periodically drying out the product
Protection against Water, Sand and Dust	IP67 Protection against blowing rain Waterproof to temporary submersion into water (maximum depth of 1m) Dust-tight, protection against blowing dust Compliance with IP67 according IEC60529 and MIL-STD-810F Method 506.4-I, MIL-STD-810F Method 510.4-I, MIL-STD-810F Method 512.4-I
Drops Vibration	Withstands 1.5m drop onto hard surfaces Withstands vibrations during operation on large civil construction machines Compliance with ISO9022-36-08

NMEA output

NMEA sentences	NMEA Data output format, internationally standardized format for data and position output, For real-time/RTK, DGPS, navigation positions, NMEA 0183 V2.20 and Leica proprietary

OWI interface

Leica proprietary Outside World Interface, enables full remote control of GPS receivers by PC, PDA

Protocol Versions	Binary or ASCII

Data links

Support of various Radio modems and GSM/TDMA cellular mobile phones for RTK, DGPS or remote control operation modes

No. of simultaneous data links	Up to two data links can be attached simultaneously using Leica GFU housing, plus two generic data links, to be used with different sensor interfaces. Or up to four generic data links can be attached simultaneously.
Radio modem Recommended radio modems	Any suitable radio modem with RS232 interface and operating in transparent mode Satelline 3AS integrated into Leica GFU housing Pacific Crest PDL receive-only integrated into Leica GFU housing
GSM phone modem Recommended GSM phone Recommended TDMA phone	Any suitable model Siemens MC75 mobile phone integrated into Leica GFU housing, 900, 1800, 1900 MHz. Sony-Ericson DM25 mobile phone integrated into Leica GFU housing
Landline phone modem	Any suitable model

Coordinate systems

	Management of ellipsoids, projections, geoid models, transformation parameters
Ellipsoids	All common ellipsoids User-definable ellipsoids
Map projections User definable and country specific	Mercator Transverse Mercator UTM Oblique Mercator Lambert (1 and 2 standard parallels) Soldner Cassini Polar Stereographic Double Stereographic RSO (rectified skewed orthomorphic projection) Other country-specific projections
Geoid model	Upload geoid model from LGO
Transformation in receiver	Classical 7-parameter 3-D Helmert One step and two step (direct WGS84 to grid)

Onboard Software

User Interface	
Graphics:	Graphical representation of points, lines and areas Application result plots
Icons:	Icons indicating the current status of measure modes, settings, battery etc.
Status information:	Current position, satellite status, logging status, real-time status, battery and memory status
Function keys:	Direct function keys for quick and easy operation.
User menu:	User menu for quick access of the most important functions and settings
Configuration	
Configuration sets:	Ability to store and transfer all instrument and application configuration settings for different operators, survey tasks etc.
Displays masks:	User definable measuring display
User menu:	User definable menu for quick access to specific functions
Hot keys:	User configurable hot keys for quick access to specific functions
Coding	
Free Coding:	Recording codes with optional attributes in between of measurements Manual code entry or selection from a user defined codelist
Thematical Coding:	Coding points, lines and areas with optional attributes when measuring Manual code entry or selection from a user defined codelist
Quick Coding:	Recording a measurement with a point code or free code by entering a alphanumeric or a numeric quick codefrom user defined codelist
Data Management	
Jobs:	User definable jobs containing measurements, points, lines, areas and codes Directly transferable to LEICA Geo Office software
Points, lines, areas:	Creating, viewing, editing, and deleting points, lines and areas and codes
Functions:	Sorting and filtering of points, lines and areas Averaging of multiple points within user defined averaging limits
Data Import & Export	
Data import:	Character delimited ASCII files with point id, easting, northing, height and point code GSI8 and GSI16 files with point id, easting, northing, height and point code
Data export:	User defined ASCII files with measurements, points, lines, codes

Standard application programs

Survey:

Measuring points, lines and areas with codes and offsets.

- Auto Points:
  High-speed surveying for mass data acquisition by automatically logging points at a given time interval, minimum distance difference or minimum height difference.
- Hidden Point:
  The coordinates of inaccessible points can be calculated by
  - measuring distances and/or azimuth to the inaccessible point using a hidden point measurement device such as the LEICA Disto or any other suitable laser range finder or by using a conventional tape
  - manually occupying auxiliary points
  - computing bearings from previously occupied points

Determine Coordinate System:

GPS coordinates are measured relative to the global geocentric datum known on WGS 1984. A transformation is required to convert the WGS 1984 coordinates to local coordinates.
Three different transformation methods are available:

- Onestep
- Twostep
- Classic 3 D (Helmert transformation)

Stakeout:

3D Staking of points using various stakeout methods:

- Orthogonal:
  Displaying distances forwards / backwards, left / right from or to the station and cut / fill.
- Polar:
  Displaying direction, distance and cut / fill.
- Coordinate differences:
  Displaying coordinate differences and cut /fill.

COGO:

Computation of coordinates of points using various coordinate geometrical methods:

- Inverse: Compute bearing and distance between 2 points.
- Traverse: Compute coordinates of points using bearing and distance from origin point.
- Intersections: Compute coordinates of points using intersections created from other points.
- Line Calculations: Compute coordinates of points based on distance and offsets along lines
- Shift, Rotate and Scale: Compute coordinates of group of points based on a shift, rotate and scale from their existing coordinates. The shift, rotate and scale values can be manually entered or computed
- Area Division: Divide areas into smaller areas using a variety of methods.

Optional application programs

Reference Line:

Defining lines and arcs, which can be stored and used for other tasks, using various methods:

- Measuring to a line / arc where the coordinates of a target point are calculated from its position relative to the defined reference line / arc.
- Staking to a line / arc where a target point is known and instructions to locate the point are given relative to the reference line / arc.
- Grid staking to a line / arc where a grid can be staked relative to a reference line / arc.

Reference Plane:

Stake-out or measure points relative to a reference plane

- Defining a plane by either measuring or selecting points.
- Calculate the perpendicular distance and height difference from a measure point to the plane.

DTM Stakeout:

- Staking out a Digital Terrain Model.
- Comparing actual and design height and displaying height differences.

Cross Section Survey:

Survey cross sections (such as highway profiles, river profiles, beach profiles) using code templates. The appropriate code for the next point on the profile is always correctly suggested.

- Also shows distance from last cross section
- Free, point, line or area codes can be used

RoadRunner:	Stake-out and as-built check of roads and any type of alignment related design (e.g. rail, pipeline, cable, earthworks) ▪ Handles any combination of geometric elements in the Horiz alignment, from simple straights to different types of partial spirals. ▪ Vertical alignment supports straights, arcs and parabolas. ▪ Covers all working tasks including stake-out/check of lines, grades/slopes (e.g. road surface, cut & fill), DTMs and many more. ▪ Visualization of cross-sections and planar view of design. ▪ Graphical selection of tasks to stake-out/check. ▪ Smart project management of design data. ▪ Support of multiple road layers (construction phases). ▪ Enhanced station equation capabilities. ▪ Comprehensive, user definable log files and cut sheets. ▪ Seamless data flow from all major design packages via PC conversion tool.
RoadRunner Lite:	▪ Same as RoadRunner, but with some functionalities removed

LEICA Geo Office Software

Description

Easy, fast and comprehensive, automated suite of programs for TPS, GPS and Level data. View and manage TPS, GPS and Level data in an integrated way. Process independently or combine data – including post processing and support of real-time GPS measurements.
Manages all data in an integrated manner. Project management, data transfer, import/export, processing, viewing data, editing data, adjustment, coordinate systems, transformations, codelists, reporting etc.
Consistent operating concepts for handling GPS, TPS and level data, based on Windows standards. An embedded help system includes tutorials with additional information.
Runs on Windows™ 98, 2000 and XP platforms.

User Interface

Intuitive graphical interface with standard Windows™ operating procedures. Customizable built-in configuration options allow users to set up the software exactly to suit their specific needs and preferences.

Standard components

Data and Project Management:	Fast, powerful database manages automatically all points and measurements within projects according to well-defined rules to ensure data integrity is always maintained. Projects, coordinate systems, antennas, report templates and codelists all have their own management. Numerous transformations, ellipsoids and projections, as well as user-defined geoid models and country specific coordinate systems which are based on a grid of correction values are supported. Six different transformation types are supported, giving the flexibility to select the approach which suits the project needs best. Antenna management system for offsets and correction values. Codelist management for code groups / code / attributes.
Import & Export:	Import data from compact-flash cards, directly from receivers, total stations and digital levels, or from reference stations and other sources via the Internet. Import of real-time (RTK), DGPS coordinates.
ASCII Import & Export	Import coordinate lists as user-defined ASCII files using the import wizard. Export results in any format to any software using the ASCII export function. Transfer point, line, area, coordinate, code and attribute data to GIS, CAD and mapping systems.
View & Edit:	The various graphical displays form the basis for visualizing data and giving an instant overview of the data contained within a project. Point, line and area information may be viewed in View/Edit together with coding and attribute information. Editing functionality is embedded allowing to query and clean up the data before processing or exporting it further.
Codelist Manager:	Generation of codelists with code groups, codes, and attributes. Management of codelists.

Reporting:	HTML-based reporting provides the basis for generating modern, professional reports. Measurement logs in field book format, reports on averaged coordinates, various processing log files and other information can be prepared and output. Configure reports to contain the information that are required and define templates to determine the presentation style.
Tools:	Powerful Tools like Codelist Manager, Data Exchange Manager, Format Manager and Software Upload are common tools for GPS receivers, total stations and also for digital levels.

GPS Options

L1 data processing:	Graphical interface for baseline selection, processing commands etc. Automatic or manual selection of baselines and definition of processing sequence. Single baseline or multi-baseline batch processing. Wide range of processing parameters. Automatic screening, cycle-slip fixing, outlier detection etc. Automated processing or user-controlled processing.
L1 / L2 data processing:	Graphical interface for baseline selection, processing commands etc. Automatic or manual selection of baselines and definition of processing sequence. Single baseline or multi-baseline batch processing. Wide range of processing parameters. Automatic screening, cycle-slip fixing, outlier detection etc. Automated processing or user-controlled processing.
GLONASS data processing	Allows processing of GLONASS data in addition to GPS data processing
RINEX Import:	Import of data in RINEX format.

Level Options

Level data processing:	View the data collected from the Leica digital level in the Geo Office level booking sheet. Select the preferred processing settings and process the level lines. Processing runs quickly and automatically. Use Results Manager to inspect and analyze the leveling results and generate a report. Finally, store the results and/or export them as required.
Design & Adjustment 1D:	Powerful MOVE3 Kernel with rigorous algorithms for 1D adjustment. Furthermore, network design and analysis is supported.

General Options

Datum & Map	LEICA Geo Office supports numerous transformations, ellipsoids and projections, as well as user-defined geoid models and country specific coordinate systems, which are based on a grid of correction values. The optional Datum/Map component supports the determination of transformation parameters. Six different transformation types are supported, giving the flexibility to select the approach which suits the project needs best.
Design & Adjustment 3D:	Combine all measurements in a least-squares network adjustment to obtain the best possible set of consistent coordinates and check that the measurements fit with the known coordinates. Use adjustment to help identify blunders and outliers based upon the extensive statistical testing. Using the powerful MOVE3 Kernel, the algorithms are rigorous and the user can choose between whether a 3D, 2D or 1D adjustment is computed. Furthermore, the component supports network design – allowing to design and analyze a network before actually going into the field.
GIS / CAD Export:	Permits export to GIS/CAD systems such as AutoCAD (DXF / DWG), MicroStation

System requirements

Minimum PC configuration:	Pentium 150 MHz processor 32MB RAM 100MB free hard disk space Microsoft® Windows™ 98 Microsoft® Internet Explorer 4.0
Recommended PC configuration:	Pentium® 300 MHz processor or higher 256 MB RAM or more 300 MB or more free space on hard disk Microsoft® Windows™ 2000 or XP Microsoft® Internet Explorer 5.5 or higher

Leica System 1200 – working together

TPS, GPS and SmartStation.
Use TPS and GPS together or separately according to the work you do.
Use whichever is the most suitable for the job in hand.
Change easily from one to the other and use them in the same way.
Enjoy all the freedom, flexibility and power of System 1200.

When it has to be right.

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Leica Geosystems AG
Heerbrugg, Switzerland
www.leica-geosystems.com

- when it has to be **right**

Leica Geosystems

PACIFIC CREST
CORPORATION

PDL
User's Guide

Revision 3.1
June 2001

PN: M0052203

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APRV

APPENDIX C - TECHNICAL SPECIFICATIONS

Environmental

Size

PDL LPB and Rover - 8.25"L x 2.40"D (21.0cmL x 6.1cmD)
PDL HPB - 6.23"W x 2.77"H x 6.58"L (15.8cmW x 7.0cmH x 16.7cmL)

Weight

PDL Rover - 0.85 lbs. (0.39 Kg)
PDL HPB - 3.22 lbs. (1.46 Kg)
PDL LPB - 0.65 lbs. (0.30 Kg)

Shock and Vibration

Per ANSI/ASAE EP455

Protection

Per IEC 144/855420 I.P. 66 Dust-tight and watertight

Temperature Range

PDL Rover Operating - -4 to 140 F (-20 to 60 C)
PDL Rover Storage - -4 to 185 F (-20 to 85 C)

PDL HPB and LPB Operating - -22 to 140 F (-30 to 60 C)
PDL HPB and LPB Storage - -67 to 185 F (-55 to 85 C)

MRU

Motion Reference Unit

Motion Reference Unit

(Pitch, Roll, Heave, and Heading Sensor)

- Various configurations available:
  - Horizontal
  - Vertical
  - OEM
- Solid State Construction
- Low Power Consumption
- Compass Option
- Heave Option
- Accurate Static and Dynamic Range
- Temperature Compensated Calibration

ORE Offshore introduces the newest member of our distinguished Navigation line; The Motion Reference Unit (MRU). The MRU is a solid state (MEMS Type) pitch and roll sensor developed specifically for marine applications. With static attitude RMS accuracy of 0.1 degrees and a dynamic accuracy of 0.25 degrees, the MRU is ready for your most demanding applications. The MRU is available as submersible unit or in an OEM version. The MRU features static references that are traceable to international standards.

What you do underwater is your business…
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ORE Offshore • 4 Little Brook Road • West Wareham, MA 02576
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Specifications
MRU

System Performance

Static accuracy	**0.1 degrees (RMS)**
Repeatability	**0.1 degrees (RMS)**
Dynamic accuracy	**0.25 degrees (RMS)**
Input Voltage	**8 to 30 volts DC**
Input Power	**1 Watt (0.75 Watt without Compass)**
Interface	**RS-232 (115.2 kbaud and 38.4 kbaud)**
Output sentence	**$POREM format (proprietary)**
Output rate	**32 updates per second**
Temperature Rating	**- 4º to 40º C (25º to 104º F)**
Compass Accuracy (optional)	**0.3 degrees**
Compass Resolution (optional)	**0.1 degrees**
Heave Accuracy (optional)	**5 cm or 5 % scale**

Weights and dimensions

Standard Version

Length	**9.5 in (24.1 cm)**
Housing diameter	**3 in (7.6 cm)**
Width	**4.5 in (11.4 cm)**
Weight	**4 lbs (1.5 kg)**
Depth Rating	**9840 feet (3000 meters)**
Material	**Hard Anodized Aluminum**

OEM Version

Length	**5.63 in (14.3 cm)**
Width	**3.3 in (8.32 cm)**
Height	**2.17 in (5.52 cm)**
Weight	**7 Ounces (0.22 kg)**

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